THE ENGINEER.

The British Industries Fair at Birmingham.

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IN this Supplement, together with its four-page plate, we continue the account of the exhibits at the Birmingham Section of the British Industries Fair, which we started in the Supplement accompanying our issue of February 15th.

PARKER, WINDER AND ACHURCH, LTD.

A new type of industrial oil burner is shown on the stand of Parker, Winder and Achurch, Ltd., of Birmingham. It is called the "Parwinac" industrial oil burner, and one of its outstanding features is the neat arrangement of the driving motor, the blower and the pump, relief valve and oil strainer on a substantial base plate with the burner attached. The motor is coupled directly to the fan and the oil pump, and the output of this unit is such that several oil burners can be supplied at the same time with air and fuel oil. The burner consists of a long barrel, down the centre of which the oil passes within the valve stem. An adjustable valve is provided, at the end of which is mounted a specially designed spinner cone, which is the only moving part in the burner. The air strikes the conical film of oil as it is leaving the valve, and preatomises the oil before it is deposited on the inner surface of the spinner cone. The oil travels along to the sharp outer edge of the revolving cone, and is thrown off in the form of a fine spray ready for combustion. The motive power for maintaining the rotation of the spinner cone is provided by the primary air striking the angular pitched vanes on the outer surface of the cone.

The valve is so arranged that it can be cleaned without withdrawing it from the furnace.

The blower is of the centrifugal type, and the gear type of oil pump is coupled to the impeller by means of a flexible coupling which drives the worm type speed-reducing gear within the pump. The auxiliary fittings include a diaphragm type of relief valve which by-passes any oil not used in the burners back to the storage tank. A strainer with a sediment trap is supplied, together with a butterfly valve for regulating the supply of atomising air. The size and type of flame is controlled by inserting tapered bushes into the end of the burner barrel. This type of burner is stated to be particularly adapted for industrial heating and to be very economical in use.

TAYLOR AND CHALLEN, LTD.

Taylor and Challen, Ltd., of Derwent Works, Birmingham, are showing several double and single-action presses, among which the high-speed notching press, shown in Fig. 1, is the most novel. This machine is intended for such purposes as making the laminations for dynamo armatures, and can be run up to speeds of from 400 to 620 notches per minute without the "register" of the notches failing to agree. The actual speed at which the machine can be run is, of course, dependent upon the inertia of the blank being worked upon and upon the spacing of the notches, but some tests to which we have subjected it show that the accuracy of spacing, even at these high speeds, is of a very high order. This effect is obtained by keeping the weight of the moving parts of the machine as low as is possible, while the frame, base, &c., are very rigid, and the dividing plate, for determining the spacing of the notches, is of large diameter. The machine shown is capable of accommodating discs of from 3½in. up to 17in. in diameter. The arrangement of the bed is such that its front edge can be adjusted flush with the outside of the die.

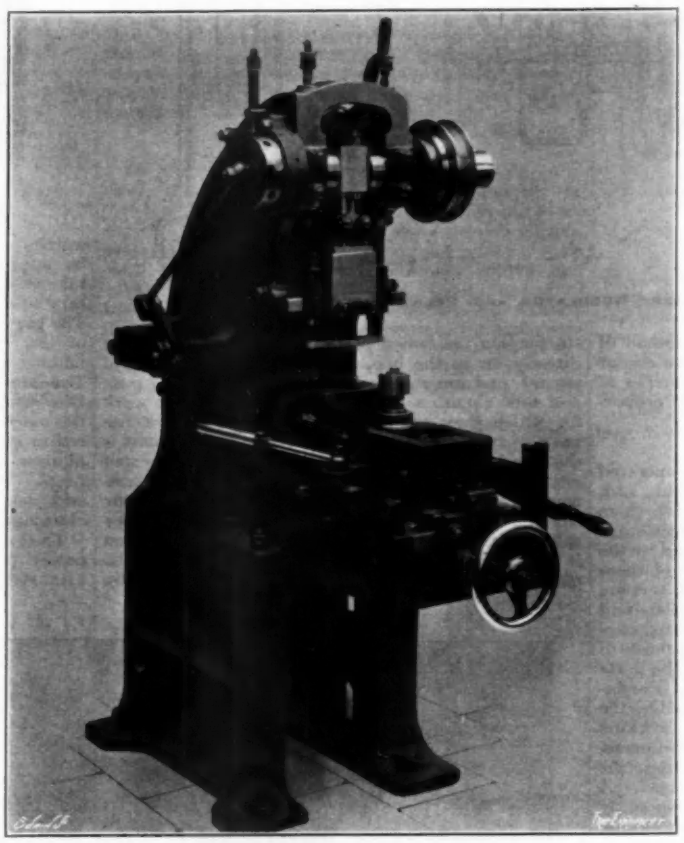


FIG. 1—NOTCHING PRESS—TAYLOR AND CHALLEN

THE DRAYTON REGULATOR AND INSTRUMENT COMPANY, LTD.

The Drayton Regulator and Instrument Company, Ltd., of West Drayton, Middlesex, has a comprehensive range of pressure and temperature regulators, including self-acting regulators for the operation of valves, together with some air and water-operated regulators. There are also some air-operated regulators for controlling one valve for one temperature impulse, and also for controlling two valves from one temperature impulse, the object of the latter regulator being to control either the supply of exhaust and live steam successively at a high temperature interval or to control the supply of a heating and cooling medium according to demand in processes where initial heating is required, but where latent heat is generally used in the process. A temperature condensation regulator and time temperature condensation regulator are also shown.

The most novel exhibit on this stand is, however, the double relay regulator, for the control of large valves, shown in the drawing, Fig. 2. The special features of this regulator provide the factor of safety and accuracy of control necessary in power plant equipment. As shown in the drawing, it is applied to the control of a steam pressure reducing valve, and is operated by water pressure.

In action the metal diaphragm A moves in response to changes in the controlled pressure to which it is connected. An increase in pressure and the consequent distention of the diaphragm, acts through the lever B on to the lever C, carrying the pilot valve disc D, so opening the pilot valve E, which is of the leak port type. Similarly, a fall in pressure allows the diaphragm A to contract and so allows the valve disc D to reclose. While the pilot valve is closed, the full operating water pressure entering the regulator through the needle valve F acts upon the bellows G attached to the piston pilot valve H, so pushing the piston J downwards. With the pilot valve E open, the water pressure entering through the needle valve F is allowed to escape and the pressure on the bellows G is relieved, allowing the spring K to push the piston valve J upwards. With this piston in the upward position a passage L, connected with the underside of the main valve operating piston N, is connected to the water supply entering through the passage O, while the passage M connected to the upper side of the piston is connected to the exhaust passage P, so that the water pressure moves the piston upwards and allows the weight R to close the main valve S. With the piston valve J in a downward position, the upper side of the piston N is connected in a downward position, the upper side of the piston N is connected to the water pressure supply through the passage M and the lower side of the piston is connected to the exhaust passage O, so forcing the main piston N downwards and opening main valve S.

The main valve S, it will be seen, is of the piston balanced type, the loading pressure on the balancing piston T, which is integral with the valve, being controlled by the position of pilot valve U. On downward movement of the valve stem V, the pilot valve is closed against the seat formed in main valve W, and the leakage past the balancing piston T allows the full high-pressure steam entering the valve to accumulate on top of the piston, so closing the main valve W until the valve stem V is held stationary and allows the main valve to recede from pilot valve U. This connects the top of the piston to the low-pressure side of the valve, and thus balances the main valve and holds it stationary. The upward movement of the valve stem V carries with it the main valve. In the fully closed position the high-pressure steam acts upon the top valve balancing piston T, holding the main valve tightly closed.

On starting up, and when the low pressure is below that for which the regulator is set, the pilot valve E is closed, applying pressure to the bellows G, forcing the spring K to push the piston valve J to the downward position, so applying pressure to the top of the cylinder piston N and gradually opening the main valve S. As the pressure rises the expansion of the diaphragm A will move the pilot valve disc D away from the seat, gradually increasing the escape of water through the pilot valve E, and so gradually moving the piston valve J upwards. When the pressure for which the regulator is set is reached, the piston valve J comes to the midway position in which it neither allows water to enter nor escape from the top or the bottom of the piston N, and the main valve S is therefore held stationary in a midway position.

If the pressure should rise slightly owing to a decrease in the demand for steam, the pressure on the diaphragm A will increase, so opening the pilot valve E and lowering the bellows G, moving the piston valve J upwards and applying water pressure to the bottom of the piston N. This closes the main valve until the correct pressure is again established. Similarly, a fall in pressure, caused by an increase in the demand for steam, will close the pilot valve E and build up pressure on the bellows G, so moving the piston valve J downwards, applying pressure to the top of the piston N, and so opening the main valve. It will be noted that failure of the water supply would bring the pilot valve J into the upward position, relieving the pressure from the top of the piston N and so allowing the weight R to close the main valve.

When used in places where the relay and high and low pressure is great, an orifice plate is inserted between the pipe line and the valve on the outlet side of the

valve. This orifice plate has the effect of reducing the velocity of the steam through the main valve at the higher loads and so minimises wear on the main valve. When used as a surplus valve the action and connections are exactly as described above. If it was used as a pass-over valve, the diaphragm A would be connected to the high-pressure side, and the action of the pilot valve E would be reversed, so that increase in pressure closed the pilot valve and a fall in pressure opened the pilot valve. Then any increase in pressure on the high-pressure side would open the main valve S, and *vice versa*. When the regulator is worked by compressed air, the construction and method of operation are similar to that described above except that slight modifications are made in the shapes of the pilot valves and they are also suitably proportioned.

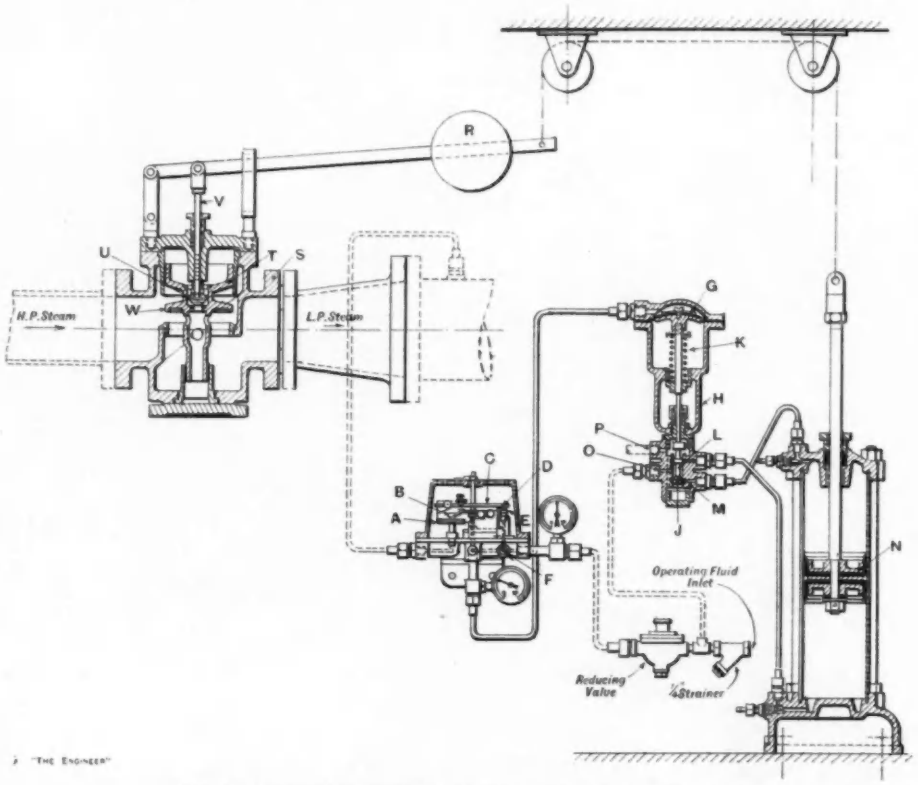


FIG. 2—STEAM PRESSURE REGULATOR AND RELAY—DRAYTON

HOLLINGS AND GUEST, LTD.

There are several hydraulic and hand-operated presses on the stand of Hollings and Guest, Ltd. Thimble Mill-lane, Birmingham, among which there will be one specially designed for the production of safety glass, and the hot-plate press illustrated by the half-tone engraving, Fig. XV. The former of these two presses is of the four-column type, with a rising table. The bottom platen is mounted on rollers and arranged to run in and out of the press on rails, thus providing for the convenient handling of the sheets of glass. The top platen is steam heated, and the ports are so arranged as to ensure the continuous circulation of the steam. The correct pressure exerted by the press and the most suitable temperature for working have been found as the result of careful experiments, and single presses are generally operated from the pump, which is self-contained with the press. A battery of presses is, however, more conveniently worked by utilising a low-pressure supply for closing the press, the final high pressure being applied by means of a hand pump.

The press illustrated by Fig. XV. is, it will be seen, of the four-column type and has steam-heated platens specially designed for the manufacture of insulating pieces for the electrical industries. The two hot plates are made of cast iron in which the steam-heating coils are cast solid, making it practically impossible for a fracture to occur at any steam pressure which may be reached. The hot plates in this press are 15in. square, machined on both faces, and polished on their working surfaces. The top hot plate is firmly fixed to the press head and the bottom hot plate is attached to the press table. The cylinder of the press is of cast iron, and is fitted with hydraulic packing. The ram is of mild steel machined and polished on its working surface, and is spigotted into the table. The four columns are of mild steel, machined all over, screwed and fitted with steel nuts. The ejector press, hydraulic propeller starter and ram pumps shown on this stand need little comment, as they are familiar to our readers. There are some rotary pumps and various moulded bakelite products exhibited by the subsidiary company, the Ellmar Mouldings Company.

F. GILMAN (B.S.T.), LTD.

On the stand of F. Gilman (B.S.T.), Ltd., Regent-street, Smethwick, there is a variety of appliances for such purposes as scaling boilers, fettling and general light work, for the purposes of which it is preferable to bring the machine to the work rather than *vice versâ*. The sets exhibited include "heads" for drilling holes from ⅛in. to ⅝in. in mild steel, emery wheels for trimming up castings, and boiler scaling tools of the Skatoskalo type, which we have described in the past. There is also the ½ horse-power general-utility set represented in Fig. 3, which is made in a standard form for all direct-current pressures up to 250 volts; but it is intended to adapt it for driving by alternating-current motors in the near future. The starter is of the switch pattern, and throws the motor directly on to the line. The motors are compound wound, and are supplied in two speeds, 2800 r.p.m. and 4500 r.p.m., according to the nature of the work for which they are required. The starter switches are also totally enclosed, and the whole motor unit is dust and weatherproof, so that it can be operated either indoors or out of doors. All the wiring connecting the motor and starter and the starter to the electric supply is carried out by means of heavy cab-tire, rubber-covered cable. The motor is fitted in an aluminium frame, which forms a base for the motor to stand upon, and affords a handle grip by means of which the motor can be carried from place to place. Where the machine is attached in a suspended position, the starter can be detached from the motor and supplied as a separate unit on its own length of cable. It can then be fixed in any position which is handy for the operator.

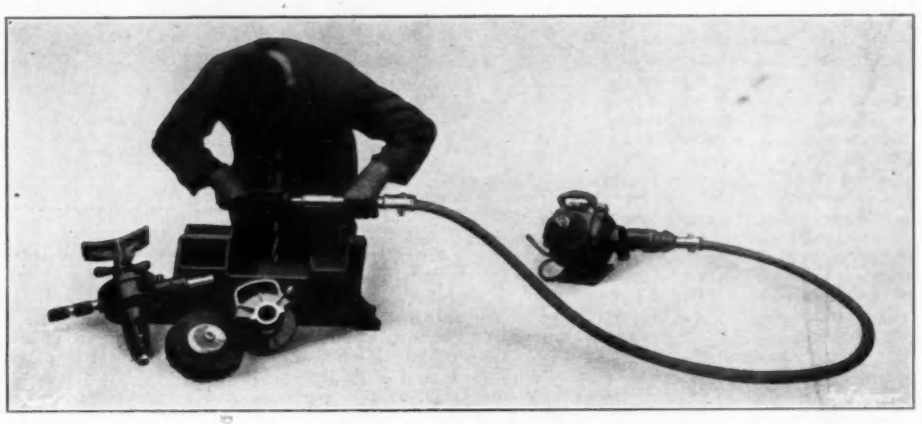


FIG. 3—½ H.P. GENERAL UTILITY TOOL—GILMAN

The method of attaching the flexible drive to the motor unit embodies a metal adaptor which screws on to a threaded boss, formed as part of the motor casing. This adaptor serves to hold the flexible outer covering in a fixed position, so that the flexible driving shaft enters the covering in a dead central position. The flexible shaft itself is attached to the motor driving spindle by a threaded sleeve. A handle, fitted with a ball bearing spindle, is attached to the end of the flexible shaft, and the machine can then be utilised for a variety of purposes, such as cleaning, buffing, scaling, drilling and so forth.

DEXINE, LTD.

The products of the Dexine Company, of Abbey-lane, Stratford, London, E 15, are generally those having rubber as a base material, but range in physical properties over a very wide scale, from soft and flexible sheet jointing material to a composition so hard and tough that it may be used for structural purposes. Into the former category it is hardly necessary to investigate, as engineers are familiar with the wide variety of uses to which a yielding material capable of withstanding considerably elevated temperatures may be put.

The example shown in Fig. 4 is, however, noteworthy as showing how Dexonite may be hardened, by appropriate admixture and heat treatment, to take the place of metallic materials, where it is necessary to resist the action of acids or other corrosives. The pump illustrated has a bore of 2in. and a stroke of 4in., and is capable of delivering six gallons per minute when running at 75 revolutions per minute. The internal parts of this pump are made entirely of Dexonite, and no soft rubber material is used, so that the machine has a reasonably long life. The plunger rod is reinforced by means of a steel rod, and the plunger itself is fitted with Dexonite twin piston rings. The ball valves for the control of the inlet and delivery are easy of access for overhaul or cleaning.

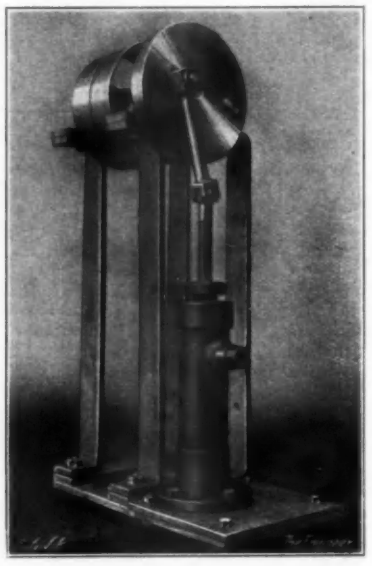


FIG. 4—ACID PUMP—DEXINE

The same firm also manufactures a horizontal power pump, having a cylinder 2½in. in bore by 4½in. stroke, which is capable of delivering 12 gallons per minute when running at 80 revolutions per minute. The pump is mounted on a substantial cast iron bed-plate, carrying pillar supports for the bearings and slides. The latter are specially provided to take the side thrust on the crosshead, so as to avoid undue wear in the gland. The plunger rod is reinforced with steel and the plunger is fitted with Dexonite twin piston rings. The valves are contained in a special valve chamber which provides for very easy inspection.

STUART TURNER, LTD.

We have in the past dealt with the neat little petrol-drive electric lighting sets made by Stuart Turner, Ltd., of Henley-on-Thames, but it is noteworthy that

the 1 horse-power—say, half a kilowatt—machine has been redesigned. This unit, which we illustrate in Figs. X. and XII., is of the two-stroke, three-port type, and has a cylinder 2⅜in. in diameter by 2¾in. stroke. It has a very light cast iron piston and the crank shaft is built up of two forgings connected together by the crank pin. Each forging comprises one end of the shaft, together with a crank web and counterweight, and the assembly is made by pressing the parts together. They are, however, assured of rigidity by means of lock nuts. The silencing of the exhaust on these engines is unusually effective, but the exhaust piping is so arranged that it is a comparatively simple matter to get at the exhaust port for decarbonisating purposes. These sets, it is claimed, will run from six to seven hours on a gallon of petrol, or on from 30 to 40 cubic feet of gas per hour, according to the quality of the gas, but they are not recommended for running on paraffin or any heavy oil. The largest plant shown at work on the Stuart stand is a 1½-kilowatt lighting plant, driven by a 3 B.H.P. engine, whilst other exhibits include small pumping plants and a special exceedingly lightweight air-cooled engine for mule pack wireless sets. This engine is used by the Royal Corps of Signals. The War Office has already acquired over 300 of them, and although solely air-cooled, they are said to function just as well under the most trying tropical conditions as in England. One of the tests which each engine must undergo is a full-load 6-hour run in an atmosphere having a temperature of 140 deg. A set which should appeal to wireless enthusiasts is one which is equipped with a double-wound armature, so that it can be used either for ordinary house-lighting purposes, or for charging a low-tension battery, while several high-tension batteries can be charged in parallel.

REYROLLE, LTD.

Owing to limitations of space, Reyrolle, Ltd., of Newcastle-on-Tyne, are unable to show their large switchgear, but a quarter-scale model—illustrated in Fig. 5—gives a good idea of all the essential

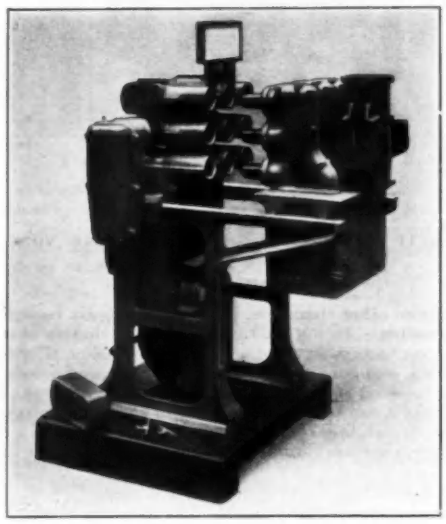


FIG. 5—SWITCH PANEL MODEL—REYROLLE

features. The model can be taken apart and sectional diagrams attached to the dividing planes give a picture of the details. Switchgear of this type is working at voltages up to 50,000, and it is built in sizes up to 1,500,000 kVA breaking capacity. All the conductors, including the bus-bars, are adequately insulated, and are completely encased in earthed metal enclosures, whilst the spaces between them and the inside walls of the enclosures are completely filled with solid insulating compound. The switchgear is made up in self-contained units built together into complete switchboards. Interlocks make incorrect sequence of operation impossible. The general construction of the gear prevents anyone accidently touching line conductors or coming within arcing distance of them. The advantages claimed for the gear are that human life is safeguarded; property is protected against damage; the apparatus is exceedingly compact; overall initial expenditure on plant and buildings is low; erection is easy and cheap; operation is simple and low in cost; the possibility of error in operation is negligible; continuity of service is secured; and maintenance expenses are small. The component parts of each unit consist of the fixed portion which incorporates the bus-bars, the instrument transformers, the cable-dividing boxes, and the supporting framework, whilst the removable portion includes the oil-immersed circuit breaker and necessary operating mechanism. The removable portion is capable of being racked out from the fixed portion, so as to facilitate inspection of the circuit breaker. Connection between the two portions is made by means of a plug and socket arrangement, which automatically isolates the circuit breakers from the live parts of the circuit when it is withdrawn. The interlocking devices referred to make it impossible to (1) plug the removable portion in when the main circuit breakers are in the closed position; (2) close the switch when the removable portion is not fully plugged in; (3) withdraw the removable portion when the main circuit breaker contacts are in the closed position; and (4) to remove the oil tank before the removable portion is withdrawn. The racking-in arrangement controls a locking bar, which automatically locks the carriage firmly in position when it is plugged home. The circuit breaker cannot be closed until the lock is secure and closed, and the lock cannot be released until the circuit breaker is reopened. The withdrawal of the switch automatically draws the locking doors over the orifices in the fixed portion, so that the conductors are completely covered when the removable portion is plugged in or withdrawn. The doors may be padlocked to prevent unauthorised handling, and this precaution affords valuable protection to life when men are working on the line. As is well known, Reyrolle and Co., Ltd., were the pioneers of the metal-clad principle of switchgear. The principle is applied to all their products, from the largest power station switchgear down to their 5-ampère protected type plugs and sockets.

Two examples of a recent development in mining switchgear are also shown by this firm. They consist of two "Mothergate" switchboards, each comprising a very compact portable distribution centre consisting of a number of 60-ampère or 100-ampère circuit breaker units, built up into the form of a switchboard, as shown in Fig. VIII. A standard 60-ampère or 100-ampère plug is fitted on each unit for the trailing cable, and the dividing box is easily detachable, so that cable rejointing is obviated when the switchgear is moved to a new position. A complete system of interlocking is provided between the circuit breaker and plug of each unit, so that incorrect working is impossible. The circuit breakers are mounted on skids to provide portability and the enclosure is of the earthed metal flame-proof type. The units exhibited are of 60-ampère and 100-ampère capacity respectively, and the larger units are fitted with an electrical interlock to the coal cutter.

FESCOL, LTD.

On the stand of Fescol, Ltd., of 101, Grosvenor-road, Westminster, various articles treated by the "Fescol" process of electro-chemical deposition are shown. The "Fescol" system, it should be pointed out, must not be confused with plating, for whilst metals such as nickel, chromium, cadmium, copper and cobalt, are dealt with, the method of application of these metals and the results obtained are entirely different from those of nickel plating, for the metal applied apparently combines with the base metal and can be built up to any desired amount within commercial limits. The process can thus be employed for the

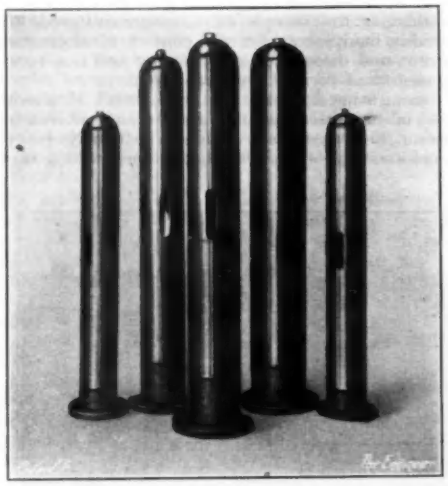


FIG. 6—EXPANSION SLEEVES—FESCOL

building up of worn parts for the protection of pieces subject to the effects of erosion and corrosion, and for decorative purposes. The illustration, Fig. 6, shows some expansion sleeves which have been treated in accordance with the "Fescol" process with nickel in order that they may resist the action of superheated steam.

The chief drawback to electrically deposited metals for rebuilding parts of mechanism has hitherto been the difficulty of obtaining a perfectly cohesive and adhesive deposit of the metal after a thickness has been attained that exceeds a few thousandths of an inch. The "Fescol" process is claimed to mark a new era for the metallurgist, chemist and engineer. Nickel, copper, chromium, cadmium, cobalt, iron, lead and zinc can be deposited, but the first two metals have been the most generally employed, and they can be deposited upon ferrous and non-ferrous metals and their alloys to almost any desired thickness. In this manner machine parts that have been subjected to wear and erosion, or which have been machined in error, can be made good. For preservative purposes the deposited metal may have a thickness not exceeding one-thousandth of an inch, but the deposit may be made very much thicker for building up worn parts. The process is said to have solved the problem of depositing nickel on nickel. It can be applied to steel, iron—cast or malleable—case-hardened parts, phosphor bronze or brass.

Fittings in nickel or chromium treated in accordance with the process are said to require little or no cleaning, even when exposed to atmospheric conditions. Any new part, made minus 0·001in. to 0·005in. all over, will resist atmospheric conditions in any climate, remaining bright in store after it has been dealt with in accordance with the "Fescol" process. The process is a cold one, and does not distort or affect the treated part in any way.

THE GENERAL ELECTRIC COMPANY.

This year the General Electric Company, Ltd., occupies the major portion of a large stand situated approximately in the centre of the section of the Fair

FIG. 7—8 kW ELECTRIC FURNACE G.E.C.

devoted to electrical apparatus. There is there a very comprehensive display of the plant, appliances, and accessories manufactured in one or other of the many factories possessed by the company in this country.

There are exhibited two electric furnaces of 8-kW and 30-kW loading, and suitable for industrial undertakings. The smaller of the two furnaces—Fig. 7—is capable of operation up to a maximum

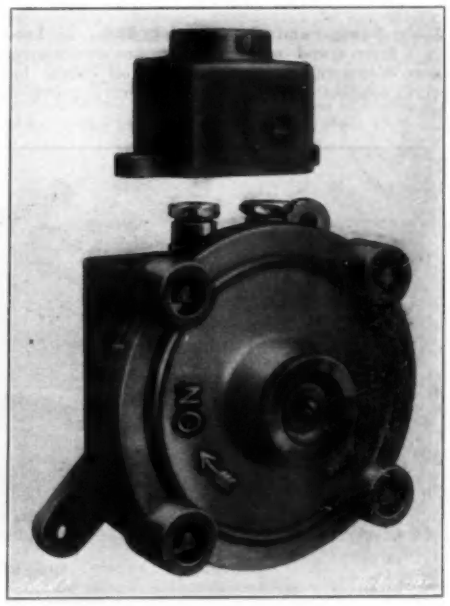


FIG. 8—FLAMEPROOF SWITCH—G.E. C.

temperature of 1750 deg. Fah. The shell is of steel plate reinforced with angles, while the door, which is of cast iron, filled with refractory heat-insulating bricks, is operated by balanced mechanism controlled by a hand lever. The muffle is of refractory fireclay, and is wound with high-grade nickel-chrome wire, arranged to give an even temperature throughout the length of the muffle. It is backed by insulating bricks, and, finally, with special magnesia-asbestos slabs. Automatic temperature control equipment is supplied with these appliances, and enables any desired temperature, within narrow limits, to be maintained. This equipment is mounted on a slate panel board, and

consists of a Cambridge regulator working from a pyrometer in the furnace, together with sensitive relay instrument transformers, time switch, pilot lamps, push-button switch, &c. The 30-kW furnace —see Fig. XIV.—is similar in many respects, but incorporates additional refinements and mechanisms necessary for the greater load. These furnaces are extensively used for such purposes as the melting of lead and bearing metals, annealing and heat treatment of various metals, vitreous enamelling, glass annealing, &c.

A "Magnet" electric japanning oven is also on view. In actual practice this oven is sunk in the floor to the rail track level. Heavy articles to be enamelled are loaded on trucks and run into the oven in the ordinary way. Doors are provided at both ends to facilitate loading and unloading. Lighter articles, such as cycle frames, &c., may be suspended from the roof. For this class of work runners are provided at suitable intervals, from front to back of the oven, with sliding hooks to allow for adjustable spacing. The heating elements are entirely encased in steel tubes, and are thus protected from all fumes, while automatic temperature control is provided with an index thermometer, which can be set to any temperature required within reasonable limits. Provision is made in the top of the oven for the extraction of the fumes during the process of enamelling.

An old Byng Hawkins motor, which has been in continuous use since 1898, and which bears the notice "My first holiday for thirty years," forms the background of the display, and is surrounded by eight of the new standard "Witton" motors, four of which are of the drip-proof squirrel-cage type, the remaining four are of the direct-current shunt-wound protected type.

The squirrel-cage motors exhibited are intended for general industrial purposes, and are manufactured with drip-proof frames. They are thus particularly suitable for all cases where protected or enclosed ventilated machines are required. They comply in every respect with British standard specification 168–1926, and, as the windings are impregnated both before and after assembly, they are capable of withstanding tropical conditions. High torque starting characteristics are a feature of these machines.

Some of the examples of ironclad switchgear shown include the G.E.C. dwarf circuit breaker, which is recommended for use in controlling small domestic appliances, cookers, testing and for changing circuits. There are some counter E.M.F. starters for direct-current motors, push-button or pilot switch control; and a 5-ampère flameproof S.P. quick make-and-break switch—Fig. 8—for use in situations where petrol vapour or other inflammable gases are present. The mining department of the University of Sheffield has issued a certificate stating that the switch complies in every respect with B.E.S.A. conditions. A triple-pole 50-ampère quick make-and-break switch, with fuse, known as the G.E.C. "D.B. Major," is also among the exhibits on this stand.

John Fowler and Co. (Leeds), Ltd.

John Fowler and Co. (Leeds), Ltd., of Leeds, have a large stand on which there are shown several classes of machinery, including the oil engine locomotive illustrated in Fig. 9. We have previously

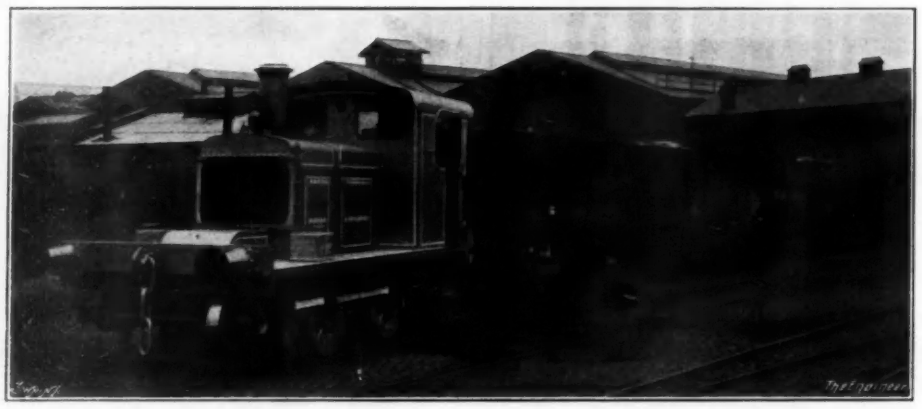


Fig. 9—40 H.P. Oil Engine Locomotive—Fowler

described this type of engine in The Engineer, so it is not necessary to give many details here, but it may be mentioned that the machine exhibited is driven by a 40 H.P. motor, while the makers also produce other sizes of from 30 H.P. up to 100 H.P. The drive is carried through a three-speed gear-box, running in oil, to a jack shaft, and thence to the driving wheels by coupling-rods. The three speeds are available in either direction. On properly laid tracks this engine will haul 350 tons on the level, or 100 tons up a gradient of 1 in 100. A 10 H.P. contractors' motor locomotive is also exhibited on a length of 24in. gauge track. Both these engines will be shown in motion.

On the same stand there are also a number of concrete mixers, some of which are fitted with hoists to raise the mixed concrete to upper floors. They are driven by Petter engines of ample power to work the mixing drum and the hoist simultaneously. There are also some concrete block-making machines and other contractor's plant, including a small stone-breaker.

The British Thomson-Houston Company, Ltd.

The exhibits of the British Thomson-Houston Company, Rugby, consist, among other things, of electric motors and control gear for industrial use. Besides standard types of alternating-current and direct-current motors the firm show single-phase reversing motors of the repulsion-induction type; vertical-spindle motors; and "built in" motors, for the direct drive of machine tool cutters; motor generators.

The B.T.H. single-phase repulsion-induction motors are designed to start up as repulsion machines, and; when up to speed, to run as induction motors, there being an external or the primary winding on the rotor which gives a high starting torque, and an internal or squirrel-cage winding, to allow only

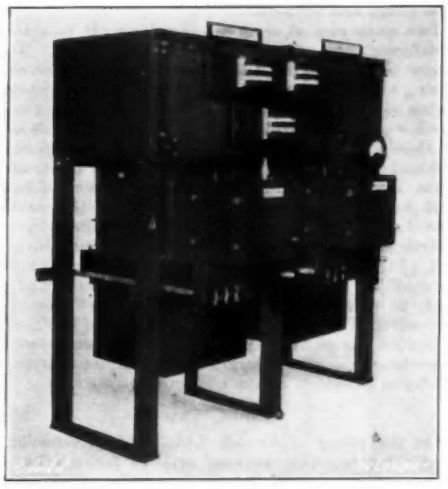


Fig. 10—Metal-Clad Switchgear—B.T.H.

a very small speed variation from "no-load" to "full-load," no centrifugal mechanism brush-raising gear, &c., being required. The machines are said to have exceptionally satisfactorily starting, accelerating and running characteristics, and as they have a high efficiency and power factor, they require only simple starting gear. They are particularly suitable for duties where high starting torque and good acceleration are required, as, for example, on passenger and goods lifts. Suitable equipments for the control of alternating-current and direct-current reversing and non-reversing motors of various sizes are shown.

Among other exhibits there is a new B.T.H. thermal type oil-immersed circuit breaker and alternating-current motor starter, designed primarily for the direct starting of squirrel-cage motors, taking up to 100 ampères starting current on voltages up to 660, and giving full protection against every kind of fault on all phases. This breaker measures only 8¾in. high by 7¾in. deep by 6in. wide, has a dust and drip-proof enclosure, and is under push-button control. By the inclusion of such special features as thermal overload protection on each phase, instantaneous short-circuit trip and low-voltage release, a breaker of this type allows a motor to carry heavy overloads for short periods, but will disconnect it on sustained overloads, as well as in the event of any irregularity developing in connection with either the supply or in the motor. The high momentary starting currents taken by squirrel-cage motors when started by direct connection to the mains are safely carried without the breaker tripping, but no overload can persist for a sufficient time to cause injury to the motor insulation by overheating. Moreover, an open circuit on one phase will cause the breaker to trip before the motor can become overheated by operating on single phase, and in the event of a short circuit occurring in the motor windings, or leads, the motor is immediately disconnected. It is also disconnected in the event of a failure of the supply. Thus maximum service can be obtained from the motor and full protection is given to the operator. For, in the event of the motor shutting down, owing to any of the causes mentioned, it cannot automatically restart on removal of the troublesome cause.

For the first time, this firm is showing its new metal-clad vertical plugging Class Z switchgear—Figs. 10 and 11—which is suitable for service under the most adverse climatic and other conditions, and its introduction makes the metal-clad construction commercially applicable for small as well as large circuits. Moreover, the utmost economy is achieved in the use of space and material. The saving effected as compared with truck type of switchgear of equivalent rating is 25 per cent. in the space necessary for installation and operation, and 43 per cent. in cubic content. The bus-bars are completely shut

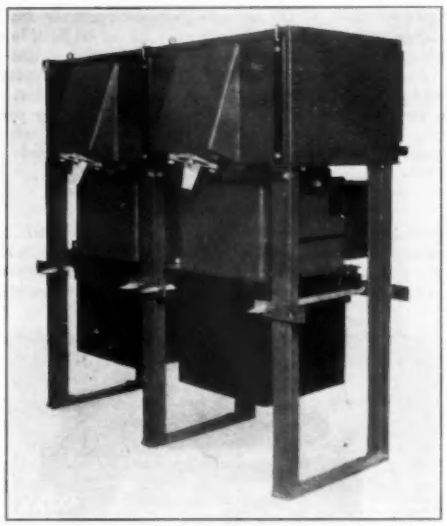


Fig. 11—Metal-Clad Switchgear, Back View—B.T.H.

off from other chambers, but they can easily be made accessible. An automatically operated shutter closes the contact socket holes when the breaker is withdrawn, and guide holes are provided for accommodating locating spears carried by the oil circuit breaker, so that it can be lifted into place in correct alignment. The circuit breaker units are interchangeable in all respects and are vermin-proof, and only one simple lifting carriage is required for a complete switchboard. The contacts are of a special self-aligning type, and the current transformers are housed in the circuit breaker top casing. They are readily accessible and interchangeable. A voltage transformer with protective fuses and a limiting resistance is mounted, when required, on the top of the fixed chamber. Contact is made with the circuit connections below, through the medium of spring pins carried on porcelain insulators in the bottom of the transformer tank. Withdrawal of the fuses through the top, isolates the voltage transformer in complete safety, and the top cannot be raised until the transformer is dead from both primary and secondary sides and until the primary is earthed. The pedestals do not require precision alignment, and a full system of automatic interlocks prevents inadvertent mishandling of the equipments.

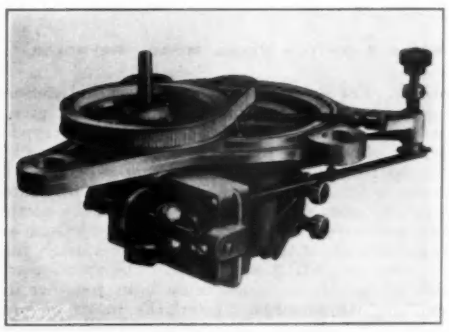


Fig. 12—Electric Gramophone Motor—B.T.H.

A section of the stand is devoted to a display of B.T.H. radio apparatus, and Mazda valves, repre-

sentative of the products of this company, and an electric gramophone motor and "pick-up"—see Fig. 12—working in conjunction with an R.K. loud speaker—is used to demonstrate the faithful reproduction of their instruments.

The current taken to operate this electrically driven gramophone motor is negligible, being no more than that of the average household lamp; in fact, 200 12in. records can be played at the cost of 1 unit of electricity. The motor is of the universal type and operates on any lighting supply from 50 to 250 volts direct current and 100 to 250 volts alternating current, at from 25 to 60 cycles, through an adjustable graduated resistance. For 60 to 100-cycle circuits another model is available. The motor is absolutely silent. It runs at 320 revolutions per minute, and drives the turntable through a woven belt, which is practically indestructible. Belt slip is prevented, and stretch is compensated by a spring tension device, while constant speed is maintained by a governor of the same design as is used on spring motors. The motor is started by a touch of the switch, which automatically stops it when a record is finished. Every care has been taken in the design of this motor to eliminate vibration, and the equipments are simple to fit to existing gramophones.

FIG. 13—SLEEVE-OPERATING BEAM

PETER BROTHERHOOD, LTD.

Particular interest attaches to the six-cylinder high-speed Brotherhood-Ricardo oil engine which is exhibited on the stand of Peter Brotherhood, Ltd., of Peterborough, since this is, we believe, the first Diesel engine to operate on the sleeve valve four-stroke principle. The design has been prepared and worked out by Messrs. H. R. Ricardo and Co., and the builders have developed some four 50 B.H.P. per cylinder engines varying in output from the two-cylinder 100 B.H.P. unit up to the 300 B.H.P. six-cylinder engine we illustrate. The intermediate sizes are the three and four-cylinder units with outputs of 150 and 200 B.H.P. respectively. The nominal bore is 7¼in., being that of the inner diameter of the sleeve valve, and the stroke is 12in., which gives, at the normal speed of 900 revolutions, a piston speed of 1800ft. per minute. This high piston speed has been made possible by the simplicity of the sleeve valve mechanism. The sleeve is given a rotary as well as a reciprocating movement, and as its velocity is nearly constant there are no difficulties in lubrication. Again, the small variation in the velocity of the sleeve valve imposes little or no inertia loading on the operating mechanism. As the drawing XVI. shows, the combustion chamber is of a very simple form, enabling forged steel cylinder heads to be used. With hardened and ground steel sleeves and pistons of aluminium alloy there is little wear. Each part of the new engine has been specially designed to meet the working conditions encountered in service, and a very light engine has been obtained. In the case of the 300 B.H.P. unit exhibited the net weight of the engine and fly-wheel works out at less than 40 lb. per B.H.P.

Access to parts has also been carefully considered, and the makers inform us that a piston can be withdrawn and replaced again within 1½ hours. The same operation can be performed for a connecting-rod and sleeve in two and four hours respectively. To take out and replace a big end brass about two and a-half hours would be required and one and a-quarter hours for a main bearing shell. The dismantling and replacement of a cylinder occupies about three hours, while the cylinder head, fuel pump and oil filter all occupy only a very short time. The overall dimensions of the 300 B.H.P. engine are:—Overall length, 9ft. 6in.; overall width, 4ft. 5in.; and overall height, 5ft. 10in. The height of the crank shaft is about 18in. above the floor level.

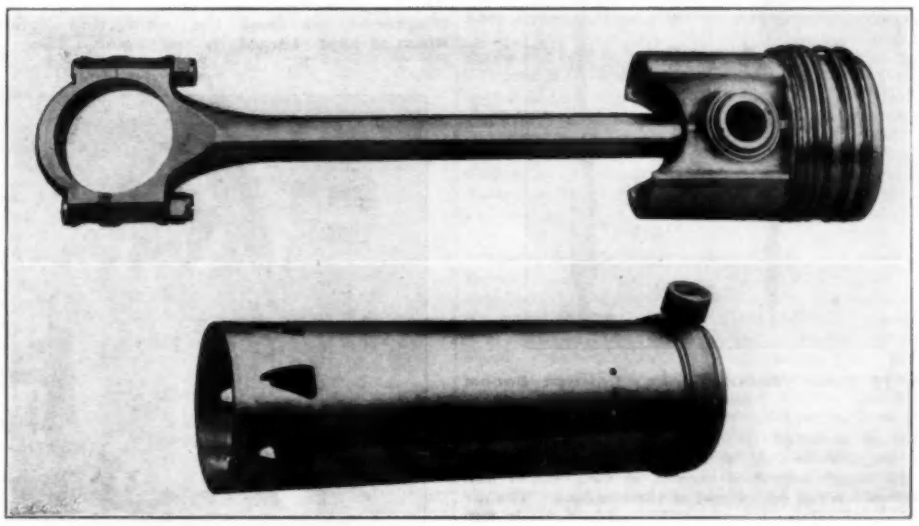


FIG. 15—CONNECTING-ROD, PISTON AND SLEEVE—BROTHERHOOD

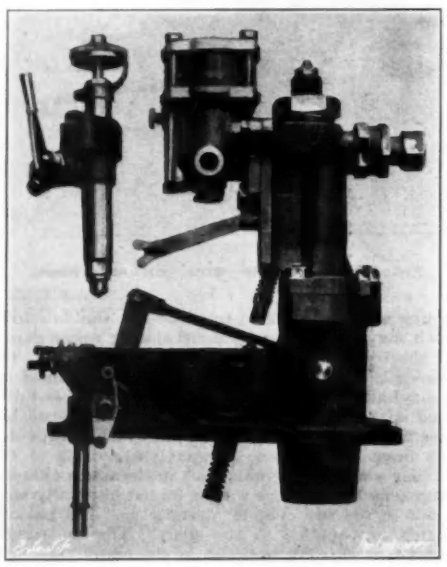


FIG. 14—FUEL PUMP

The makers guarantee a maximum full-load consumption of fuel of 0·38 lb. per B.H.P. per hour in the case of the larger engines and 0·40 lb. for the smaller sizes, while the lubricating oil consumed is guaranteed not to exceed one pint of oil per hour per 150 B.H.P.

As will be seen from the sectional drawings, the bed-plate is of a deep stiff section with the main bearings carried on double walls. The bed-plate is water cooled with a series of coils. The bearing caps are steel stampings secured by four collar studs. A built-up crank shaft is employed with case-hardened journals and crank pins. The main bearings are fitted with white-metalled bronze shells and the crank pin has a loose bronze bearing which is free to rotate on the crank pin. Fig. 15 shows the steel connecting-rod, machined from a steel stamping, and the aluminium alloy piston. The small end of the connecting-rod is provided with a bronze bush, and the gudgeon pin, which is hardened and ground, is quite free to float within this bush and in the piston. As shown in the same figure, the steel sleeves are furnished with inlet and exhaust ports. The sleeves are case-hardened and are finished by grinding them to very close limits.

The crank case is a light stiff casting provided with large inspection doors, through which, if necessary, the big ends, main bearings and sleeve-operating gear can be withdrawn.

Separate castings of symmetrical construction form the cylinders, and the valve ports are machined in the same manner as those in the steel sleeves. The cylinders have large water jackets and the cooling of the exhaust ports has been carefully considered. Large inspection doors giving access to the water spaces are provided. The pistons are made of an aluminium alloy and carry three pressure rings with one scraper ring.

The cylinder heads, which are well illustrated in our page plate Fig. XVI. and in Fig. VI., are made in steel and are machined all over. They are mounted on the cylinder with junk rings, which give a gas-tight joint between the sleeve and the head. The shape of the combustion chamber is so designed that a high degree of turbulence is produced, giving very complete combustion. The fuel valve is fitted at the front of the cylinder and it is very simple in design. It comprises a valve with a spring-loaded steel ball, the hardened steel sprayer cap having a single plain ball of comparatively large size which cannot easily become choked. A relief valve is also fitted on the cylinder cover, together with an air starting valve. A separate fuel pump is provided for each cylinder, and a view of the pump with the atomiser is given in Fig. 14. The fuel pumps are driven from the outer end of the sleeve-operating bearing. Governing is effected by opening and closing the spill valve, so as to leave the fuel injection timing constant.

Starting is effected by compressed air, and an air compressor is built into the end of the engine. It is driven from the sleeve-operating helical gears at a reduced speed. The compressor can be put in and out of action by a lever shown at the end of the engine. There are two lubricating oil pumps at the end of the engine, which are gear driven and work in conjunction with an "Autoklean" strainer. Fixed to the side of the bed-plate is a four-cylinder air motor which is coupled with the pinion of the Bendix self-releasing starting gear and engages in teeth provided in the fly-wheel.

BROOM AND WADE, LTD.

On the stand of Broom and Wade, Ltd., of High Wycombe, there is shown a wide range of air compressors and pneumatic tools. One of the largest exhibits is the portable air compressor set shown in Fig. VII., comprising a petrol engine-driven air compressor designed for an actual output of 110 cubic feet of air per minute at a working pressure of 100 lb. per square inch. The compressor has a bore of 6in. and a stroke of 6½in. and the above output is obtained when running at a speed of 660 revolutions per minute. At 600 revolutions per minute the output is 100 cubic feet per minute. A 25 B.H.P. four-cylinder Dorman engine is used to drive the air compressor. The air governor on the air compressor is connected to the

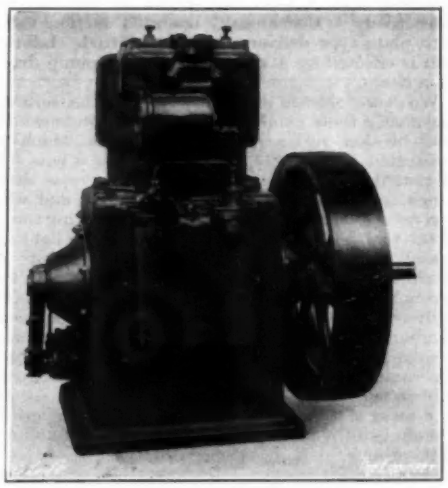


FIG. 16—AIR COMPRESSOR—BROOM AND WADE

engine throttle and is so set that it automatically slows down the engine when the required pressure has been attained in the receiver. This arrangement is one which ensures the maximum economy in petrol consumption. Another exhibit is a 55 cubic foot portable compressor set of generally similar design, suitable for a working pressure of 100 lb. per square inch. The engine is a Lister petrol engine of 12–14 B.H.P. and the compressor runs at 600 revolutions per minute, the bore and stroke being both 5in. The firm is also showing an example of its new design of rotary air compressor, which possesses some interesting features. This particular type of machine is recommended for pressures up to 30 lb. per square inch and it is built in several different sizes embracing outputs of from 15 up to 150 cubic feet of free air per minute. In the case of the smaller sets the

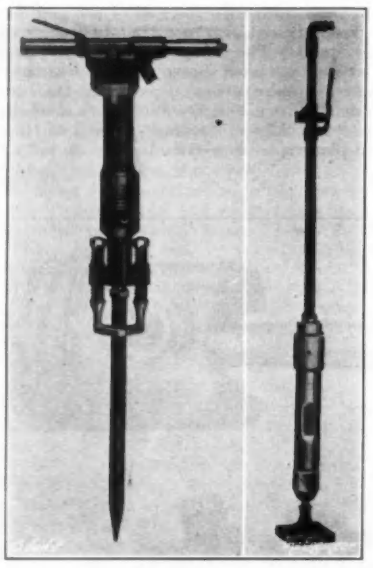


FIG. 17—ROAD BREAKER AND RAMMER—BROOM AND WADE

drum is mounted in such a manner that it is free to revolve on a single ball bearing, while in the larger sets it is carried on two sets of ball bearings, one at either end of the machine. The air intake and delivery ports are formed in a fixed plate at the end of the machine, and the makers claim that by adopting this arrangement they are able to obtain a very large port area, with a consequently high volumetric efficiency and a maximum output from a given size of machine. It is further stated that in the new design leakage is reduced to a minimum and that silent running is assured, while there is, we are informed, freedom from the trouble experienced when ridges are formed in the drum which surrounds the blades. Again, the lubrication has been so arranged that it is automatic and there is no trace of oil in the delivery air, although the machine and blades are both sufficiently lubricated. In Fig. 16 we show the vertical two-cylinder air compressor of standard design arranged for belt driving. The cylinders have a bore and stroke of 7in. and 8in. respectively. Mechanically operated suction valves with plate type delivery valves are fitted. Lubrication is effected by a small valveless oil pump driven by a chain.

We have chosen for mention from the series of pneumatic tools exhibited a typical "Broomwade" road breaker and a pneumatic rammer, which are illustrated in Fig. 17. In all the tools a new style of patented plate type distributing valve is fitted, which, it is claimed, is simple in design, and while it gives a good air economy is capable of lasting the life of the tool. The road breakers, both of the light and heavy types, are fitted with a new type of tool retainer, which has been designed in such a way that spring breakages are now reduced to a minimum. The light type of breaker can be employed for heavy clay digging and asphalt cutting besides the usual road breaking and demolition work. A new feature of the rammer design is the fitting of interchangeable rubber butts and panes. These parts are secured in a taper slot and may be engaged or disengaged by a slight tap. A variety of caulking hammers equipped with various types of tools are also shown.

TANGYES LIMITED.

The exhibits shown on the stand of Tangyes Limited, of Cornwall Works, Birmingham, include, besides three working oil engines, ranging in powers from 6 to 144 B.H.P., a series of both centrifugal and ram pumps, and a variety of the firm's well-known pulley blocks and lifting jacks.

The largest engine is the twin-cylinder cold-starting oil engine, shown in Fig. XI. (see Supplement). The designed output of this unit is 144 B.H.P., or about 170 I.H.P. at 240 revolutions per minute, and the cylinders have a bore of 14¾in., with a stroke of 21in. As will be seen from the engraving, the two cylinders are cast in one with the bed-plate so that a very rigid structure is obtained. The fly-wheel is of a very massive type, and is furnished with teeth which engage with the pinion of the hand barring gear. The combustion chambers form a separate casting and the exhaust inlet and fuel valves are all arranged to permit the maximum ease of access. The valve gear for both cylinders is operated from one side shaft, which is driven from the crank shaft by skew gear wheels. At the centre of this shaft the vertical centrifugal governor is arranged which operates directly on to the fuel pump. Any excess of fuel oil is automatically by-passed to the fuel oil tank, which is furnished with a suitable oil filter. A speed regulator is fitted, enabling the speed of the engine to be increased 2½ per cent., or decreased 5 per cent. while the engine is at work. The governor is designed to give very close speed regulation independently of the load at which the engine is required to work.

Lubrication is effected by sight-feed mechanically operated lubricators worked from the side shaft, which deliver oil to the liners and pistons, the cross-heads and crank pins, and the exhaust valve guides. The bearings of the side shaft and crank shaft are ring lubricated. As illustrated in Fig. 18, a new type of super-compression starting equipment is fitted on this engine, which is typical of the firm's practice for the larger engines. The object of this arrangement is to raise the compression in the cylinder during the starting period by the admission of a small amount of compressed air from the air-starting cylinder, which is kept charged by the engine. There is a

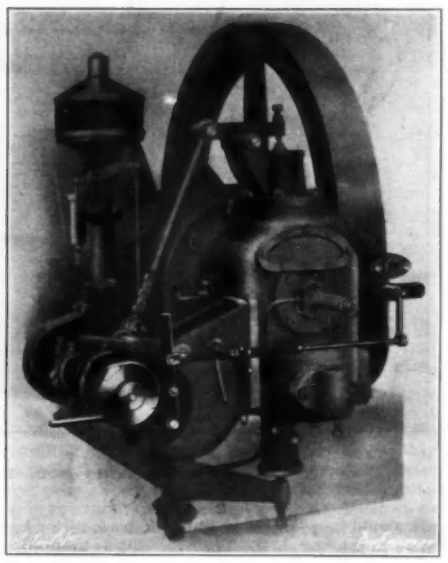


FIG. 18—STARTING GEAR—TANGYE

special cam mounted on the end of the side shaft which operates a lever controlling the supply of air from the receiver. The cam is put into operation by sliding it along the shaft, and it opens the starting air valve at such a time that a small quantity of highly compressed air is admitted to the cylinder at the beginning of the compression stroke. The final compression pressure is then such that the fuel oil sprayed into the cylinder immediately ignites. After the engine has run for a few seconds, the combustion chamber becomes sufficiently warm, so that along with the heat of the normal low-pressure compression, there is sufficient heat to ignite the fuel. The cam is then once more moved out of position, the starting air cut off, when the compression pressure falls about 20 per cent. The starting compression is about 350 lb., and the normal working pressure about 280 lb. per square inch.

Two other exhibits are the self-contained 6 B.H.P. lamp-starting fuel oil engine, shown in Fig. IV. which is shown driving the 4in. by 6in. vertical treble ram pump illustrated in Fig. V. This pump is designed to work against heads up to 300ft., and is arranged with a back countershaft for belt driving through gearing. The pump bodies are cast in one with the bed-plate, giving a very compact arrangement, and the bored guides are cast with the standards. The pump referred to is designed for an output of 2350 gallons of water per hour. Both the suction and delivery valves are arranged at the back of the pump body and an air vessel is fitted to the delivery branch. Another exhibit is a 19 B.H.P. oil engine, driving a dynamo for lighting purposes.

BOULTON AND PAUL, LTD.

The exhibits of Boulton and Paul, Ltd., Norwich, consist of an automatic lighting set, a portable fire and general utility pump, a single-cylinder petrol-paraffin engine, a domestic electrically driven pump, and two "Boulton" water elevators.

The "Lowrev-Turbo" portable fire and general utility pump is illustrated in Fig. 20. This appliance has been made by the firm for over fifteen years, and has recently been redesigned to increase its general utility. The engine and pump remain the same as before, but the earlier four-wheel chassis has been replaced by one with two wheels, and the weight has been considerably reduced. The convenience and speed of carrying out the priming operation have been improved by fitting the appliance with a hand-exhausting pump. Solid rubber or pneumatic tires can be fitted to the wheels, so that the pump, if required, may be trailed at high speed behind a motor car. The pump is capable of throwing an effective fire jet through a ¾in. nozzle to a height of 50ft. through 200ft. of 2½in. canvas hose. It can also deliver useful jets through two ½in. nozzles. At a total head, including suction, of 50ft., the maximum output at full engine speed is 105 gallons per minute. At 100ft. head the output is 75 gallons a minute. The pump is of the six-stage centrifugal type, with gun-metal impellers machined all over, and runs at a speed sufficiently low to permit it to be coupled directly to the engine to the exclusion of all gearing or belting. The engine has a single cylinder, and is of the same type as that used in the firm's "Electolite" lighting sets. It is fitted with a silencer and with a spiral helical lubricating oil pump.

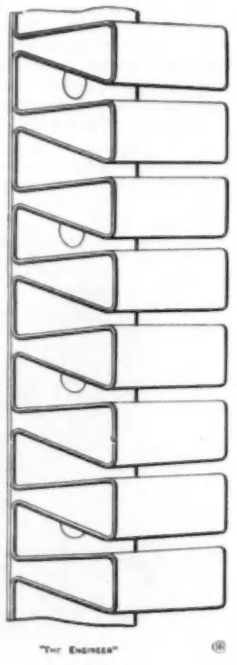


FIG. 19

The single-cylinder petrol-paraffin engine exhibited by the firm is shown in Figs. XIII. and 21. This type of engine finds many applications of a widely varied nature, such as for driving dynamos, pumps, air compressors, sheep-shearing machines, welding sets, concrete mixers and so forth. It is made in four sizes, two with single cylinders and two with twin cylinders. On petrol the horse-powers are 4, 5·2, 8·5, and 9·6 B.H.P., and on paraffin 3, 3·4, 5·3, and 6·75. In all cases the speed is 1000 r.p.m. The smallest size weighs 250 lb., and the largest 475 lb. The engines are fitted with a high-tension magneto, a "Solex" carburetter, a centrifugal governor, pump lubrication, an exhaust silencer, and a fuel tank. If paraffin is to be used, a double-compartment fuel tank or two separate tanks can be supplied.

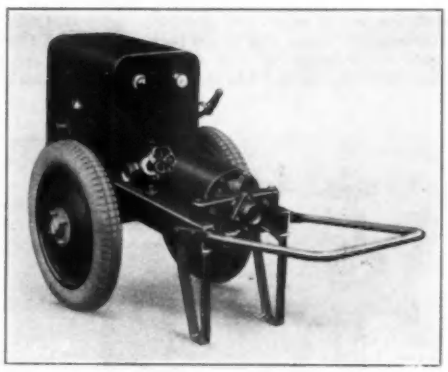


FIG. 20—FIRE PUMP—BOULTON AND PAUL

Cooling water is supplied from a tank, the flow from which may be assisted by a circulating water pump. In the design simplicity, accessibility, and the absence of small working parts have been aimed at. The cylinder is fitted with a detachable head provided with a copper-asbestos joint. The piston has three rings, and has a gudgeon pin which is provided with brass end pads to prevent the scoring of the cylinder walls. The crank shaft in the single-cylinder designs has the balance weight forged integrally with it, but in the two-cylinder designs cast iron balance weights are applied to the shaft. The centrifugal governor is entirely enclosed in the crank case, and is such as to permit the speed of the engine to be adjusted while it is running. The cam shaft, of case-hardened and ground steel, is formed in one with the cams and the skew gearing. The tappets are operated by rocking levers, and adjustment is provided for the tappet clearance. The connecting-rod is of 3 per cent. nickel steel, heat-treated. It is fitted with a gun-metal small end bush, and at the big end with renewable bearings of die-cast anti-friction metal. In the single-cylinder engine, lubrication is effected by means of a spiral helical pump, driven by skew gearing from

the crank shaft, the oil being lifted from the sump and delivered into a splash trough in which it is maintained at a constant level. In the two-cylinder models the pump is of the gear type, is placed in the sump, and is driven by chain. The oil is fed through a filter directly to the main bearings, and to troughs into which the connecting-rods dip. The valve gear is enclosed in an oil-tight compartment, provided with an inspection door, the removal of which permits the ready adjustment of the valves.

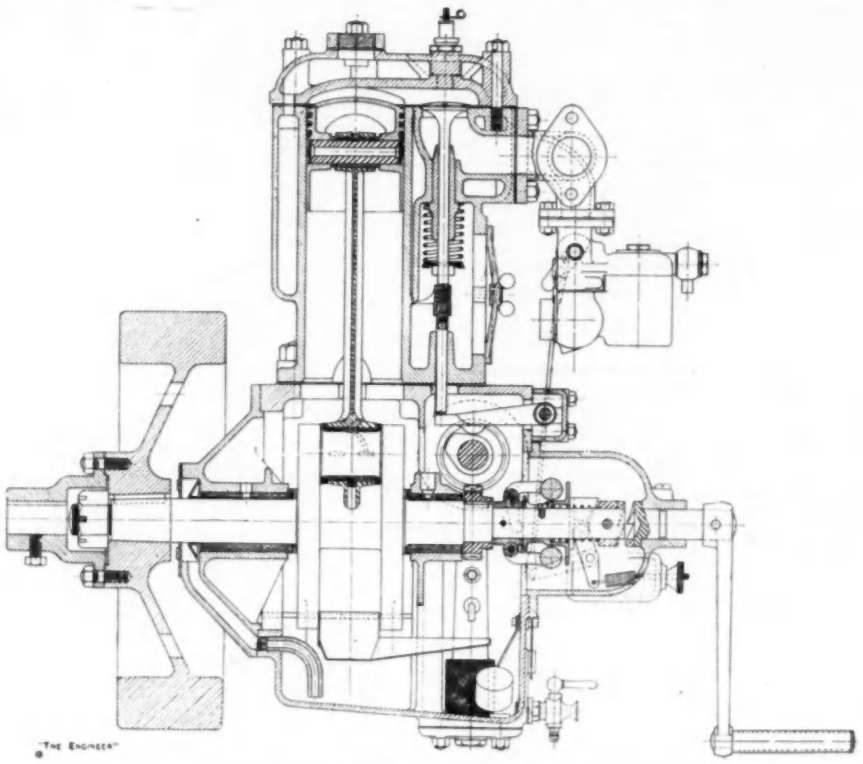


FIG. 21—PETROL-PARAFFIN ENGINE—BOULTON AND PAUL

In the single-cylinder paraffin engines, the initial heating is effected by running the engine on petrol for a few minutes. In the two-cylinder models a vaporiser is used. A lower compression ratio, achieved by means of a deeper cylinder head, is employed in the paraffin engines. The smaller of the single-cylinder designs is embodied in the "Lowrev" pump illustrated in Fig. 20.

The heavy-duty "Boulton" water elevator shown by the firm is capable of dealing with 100 gallons per minute. This form of elevator is claimed to be particularly suitable for collieries, small waterworks, breweries, general factory requirements, the irrigation of tea gardens, and many other purposes, and is applicable to wells up to 300ft. in depth. It is designed in accordance with the Caruelle patents, and is claimed to be low in first cost and in running expenses. The ancient form of water elevator, still extensively used in India, consists of an endless rope or band, to which at intervals earthenware jars are attached. As the band passes over a top wheel, the jars empty themselves into a receptacle. These elevators have to be worked at a very low speed, because the jars will not fill if plunged into the water at a high speed. Further, as the load to be lifted is great, 50ft. is about the limit of lift which can be worked without exceeding the strength of the band. The "Boulton" water elevator makes use of a high-speed endless band, the whole length of which is provided with open-ended cells made of aluminium bronze and shaped as shown in Fig. 19. After the band dips into the water, surface tension retains the water within the cells so long as the band is vertical. As the band passes over the top wheel, centrifugal force breaks down the surface tension and the water flows out of the cells into an adjoining tank. Tests carried out by Sir Alfred Chatterton have shown that when raising water from a well 152ft. 6in. deep the efficiency of the band at all speeds from 6ft. to 11ft. per second was between 90 and 95 per cent. The lower end of the band dips about 3ft. into the water to be elevated, and passes round a bottom pulley, which is weighted in such a way as to overcome gyroscopic and pendulum forces. No guides are required to prevent the band twisting, unless the well or shaft exceeds 100ft. in depth. In Fig. I. we illustrate the head gear of an electrically driven water elevator, with which is combined a high-lift centrifugal pump, whereby the water raised by the elevator is subsequently lifted to an overhead storage reservoir. The centrifugal pump takes its supply directly from the elevator base. The drive is transmitted from the pump shaft to the elevator, through reduction gearing.

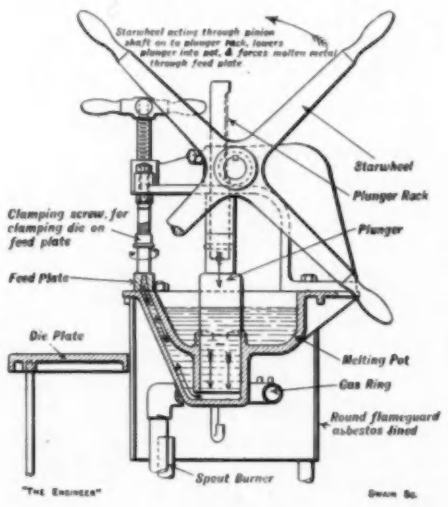
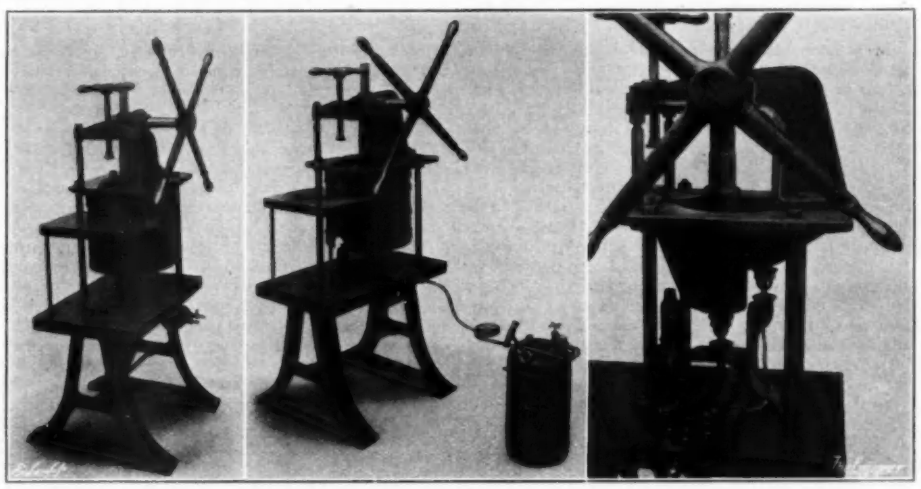

Starwheel acting through pinion shaft on to plunger rack, lowers plunger into pot, & forces molten metal through feed plate
Starwheel
Plunger Rack
Plunger
Clamping screw, for clamping die on feed plate
Feed Plate
Die Plate
Melting Pot
Gas Ring
Round flameguard asbestos lined
Spout Burner
"THE ENGINEER"

FIG. 22

W. H. DORMAN AND CO., LTD.

There are two distinct classes of exhibits on the stand of W. H. Dorman and Co., Ltd., Stafford. They comprise examples of this firm's flexible steel pipe, made of short sections of solid-drawn tubing connected by means of ball and socket joints. This piping, which is known as "Flexstel," is capable of withstanding very high pressures, and is claimed to be drip-tight. The other class of exhibit includes castings in various metals, and the die-casting machines used in their manufacture. We illustrate two of these machines in Figs. 23, 24 and 25, while the sketch, 22, shows the internal arrangements.

In these machines the melting pot, which is made from a special alloy, has an additional well portion, into which the plunger works. This plunger is operated by means of rotating a hand wheel, which is connected by a rack and pinion. As the plunger is gradually brought to the bottom position, the metal is forced under pressure through a special duct from the well portion to the feed plate on which the die is clamped. The metal ingots should, of course, first of all be broken up and placed in the container for melting, and the plunger should be at the top position during this process. When the metal appears fluid the plunger is moved down slowly, which expels some of the molten metal through the casting hole in response to the movement of the plunger. A uniform level of metal should be maintained in the container during casting, and this level should be within 2in. of the top. The warm die is placed over the casting hole and clamped down with the clamp screw. A steady, even pull on the hand wheel is all that is necessary to fill the die, but the pressure should be kept on a few seconds after it is felt that the die is full. When the dies are at the correct temperature, the metal, after casting, will be just set. The standard "Dorman" machines are heated by means of ordinary gas burners, but for cases where gas is not available, the makers have adapted their machines for firing by means of oil fuel burners. This method, also, is very efficient, and consists of a group of "Primus" type burners. The machines are supplied complete with the necessary fuel tank which has a capacity sufficient for an eight hour day run. These machines do not need any special foundation or bolting down, but should be installed in a position where they will not encounter a draught. Connection from the burners to the gas mains can be made with ordinary rubber tubing.



FIGS. 23, 24, 25—DIE CASTING MACHINES—DORMAN

MONEL-WEIR, LTD.

The increasing range and diversity of the uses of Monel metal and pure malleable nickel are strikingly exemplified in the display of exhibits on the stand of Monel-Weir, Ltd., of Cathcart, Glasgow. We may divide the exhibits into four groups, those representative of engineering and power plant applications, chemical industrial apparatus, applications in the dyeing and textile industries, and finally a wide range of uses embracing food preparing machinery, hospital instruments, and equipment and general hardware and shop fittings. It may be recalled that Monel metal is mined as a natural ore at Sudbury, in Ontario, Canada, and is smelted under careful technical control so that the constituent metals of which it is composed are not separated out. It consists of about 67 per cent. of nickel, 28 per cent. of copper, and about 5 per cent. of other metals.

The hot-rolled metal in the form of bars has a strength of 30 to 42 tons per square inch, according to the size of the rods and their heat treatment. In the form of cast metal the tensile strength is 19 to 25 tons per square inch, but by special design castings have been produced with a tensile strength of 32 tons per square inch and an elongation of 28 per cent. At high temperatures its tensile strength does not fall off so rapidly as that of some other metals, and at 750 deg. Fah. forged Monel rod has a strength of over 35 tons per square inch. The hardness and tensile strength of the metal can be greatly increased by cold drawing, and a Brinell hardness of 237 with a tensile strength of 58 tons have been obtained in this way.

In order to illustrate the advances recently made in the manufacture of Monel metal condenser tubes a model condenser of the marine type is shown, which is illuminated internally to show the high standard of manufacture.

Prominent among the engineering exhibits there is

the standard G. and J. Weir, Ltd., boiler feed pump shown in Fig. IX., which is of the turbine-driven type and is designed for an output of 7000 gallons per hour. Standard Monel metal blading is shown in the turbine, and the pump impeller is an example of a Monel metal casting. The weight of this set is about 1150 lb., and such pumps are now designed to operate at speeds up to 5000 revolutions per minute under continuous service conditions. Other examples of Monel metal articles include valve spindles, propeller shafts, and also carbon garter springs for turbines. Some of the valves and cocks are made by Charles Winn and Co., Ltd., of Birmingham, and the Interlock Metallic Hose Company, Ltd., show some specimens of Monel metal flexible hose. An interesting example is a Monel metal centrifugal basket, which is shown by Pott, Cassels and Williamson, Ltd., of Motherwell, and there is a selection of solid-drawn tubes such as are used in heating and cooling coils, evaporators and rollers for chemical work. With regard to textile applications and dyeing plant, a full-sized jigger lining is being shown along with some scale models of different types of dye tanks and vats. The remainder of the exhibits are devoted to Monel metal articles for home, shop and hospital use. The Aluminium Plant and Vessel Company, Ltd., of London, is displaying a pure nickel lined pasteuriser, while the ornamental character of Monel metal is clearly seen in a model shop constructed for this purpose by the Imperial Shop Fitting Company, Ltd., of London.

LACY-HULBERT AND CO., LTD.

The general style of the air compressors made by Lacy-Hulbert and Co., Ltd., of Boreas Works, Beddington, near Croydon, is so well known to our readers that the peculiarities of these machines, especially in the way of high volumetric efficiency, need no emphasis here; but the two sets illustrated in Figs. II. and III. are novel exhibits. Of these, the unit shown in Fig. II. is primarily intended for garage purposes, that is to say, for supplying air to inflate pneumatic tires. It has a capacity of 6 cubic feet of free air per minute, and is directly driven by a 2 horse-power electric motor running at a speed of 1400 revolutions per minute. The air compressor is of the water-cooled type, and is fitted with ball or roller bearings for the running parts. Its piston is of aluminium and pressor is hopper-cooled, the whole set is very compact, and it is mounted on two pneumatic-tired bicycle wheels, as shown. All necessary fittings,

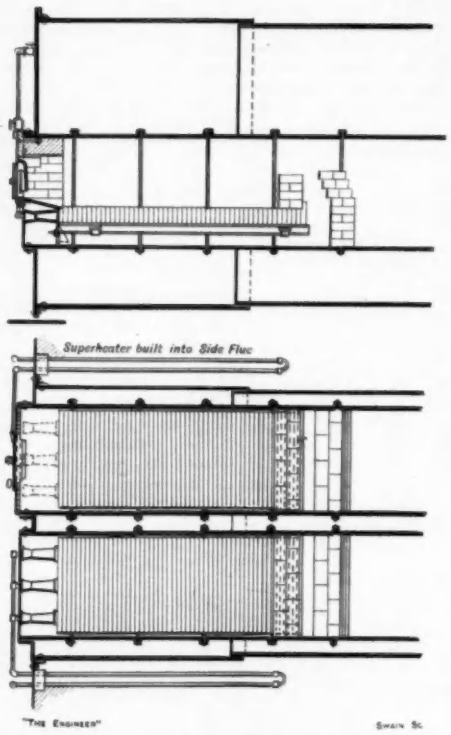


FIG. 26—FORCED DRAUGHT FURNACE—CROSTHWAITE

such as a pressure gauge, safety valve, drain cocks, exhaust silencer and petrol tank, are provided. The T handle shown is removable, so that the space occupied by this set is remarkably small. It occupies, in fact, a space of only 40in. by 44in. by 28in., when the handle is removed, while its weight is 5¼ cwt.

THE CROSTHWAITE ENGINEERING AND FURNACE COMPANY, LTD.

Two forced draught furnaces for Lancashire boilers are shown on the stand of the Crosthwaite Engineering and Furnace Company, Ltd., York-street, Leeds, and they are both illustrated in the drawings, Figs. 26 and 27.

The chief peculiarity in the first-mentioned furnace, which is intended for hand firing, lies in the design of the fire bars. The bars are arranged transversely to the furnace and have a series of holes cast in them in such a way that when they are assembled in the furnace the holes form continuous passages for the admission of air to the fire through narrow slits in the upper faces of the bars. The air for this purpose is forced into the passages by steam jets. There are other passages through the bars which conduct air, under natural draught, to the back of the furnace. This air is warmed on its way through the bars, and helps to promote combustion at the bridge. It is claimed for these furnaces that they will effect an economy of from 20 to 30 per cent., as compared with a boiler fitted with an ordinary grate, that they will increase the evaporative capacity of the boiler by about 20 per cent., and that with them the cheapest grades of fuel can be burned.

In the case of the mechanical stoker—see Fig. 27—the fuel is fed into hoppers, at the bottom of which, each has a feeder slide. This feeder slide has a forward and backward motion actuated by a cam on the driving shaft. By means of a simple arrangement of screw and nut, the stroke of the feeder can be easily regulated to suit the rate of combustion required, without stopping the stoker. The fuel, in small quantities, is pushed by the feeder over the edge of the feed-box on to the firing nose, being divided during the same process. The fuel is then thrown on to the grate by means of a swinging shovel. The shovel is carried by a strong single central arm which swings in a passage directly through the centre of the feed box. The swinging arm is carried on a horizontal shaft, which also carries at one end a curved cam lever with a nickel chrome steel roller. At the other end there is a spring lever, to which is attached a tension spring. The curved cam lever is operated by a three-point finger cam mounted on the driving shaft. This cam is not keyed to the shaft, and is therefore free to rotate in advance of its normal position on the shaft. When the cam is bringing the shovel to the back position against the tension of the spring, it is driven by a pin from the feeder cam and immediately the roller reaches its extreme limit the cam flies forward, thus giving the cam lever freedom to swing clear of the cam, and give the spring full play to actuate the shovel.

This furnace is of the reciprocating type, the grate being divided longitudinally into close-fitting sections, each section being a complete and separate unit. The design of the grate bars is based on the same principle as that described above. Each unit or section of the grate is driven by independent cams, which are fitted to a mild steel hexagonal shaft at the front of the furnace. These cams are made of a special chilled mixture and work on to wearing

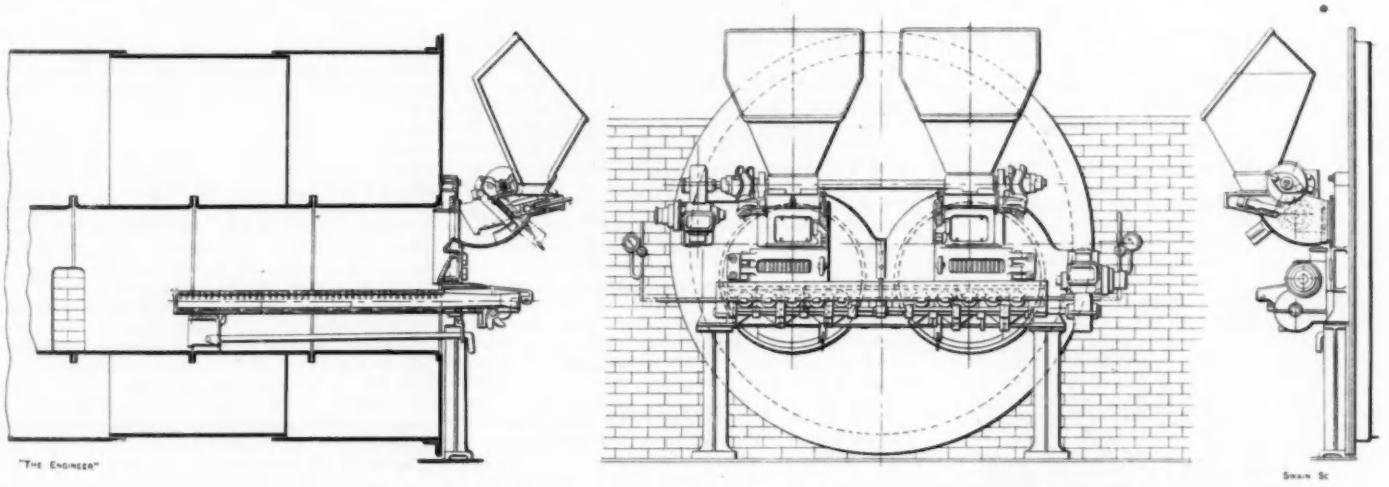


FIG. 27—GENERAL ARRANGEMENT OF FORCED DRAUGHT SELF-CLEANING FURNACE—CROSTHWAITE

the lubricator is entirely automatic. The air receiver of these sets is tested to a pressure of 300 lb. per square inch, and is provided with appropriate fittings, such as a safety valve, pressure gauge and so forth. An almost identical equipment is also supplied by this firm for paint-spraying purposes, but in this case the air capacity is from 9 to 10 cubic feet of free air per minute at a pressure of 100 lb. per square inch.

The portable compressor represented in Fig. III. is very similar, as far as the compressor itself is concerned, as that just described, and is capable of delivering 8 cubic feet of free air compressed to a pressure of 100 lb. per square inch per minute. It is driven by a Lister petrol engine equipped with magneto ignition, a radiator and a fan. The engine and compressor are direct coupled by means of a flexible coupling, and are mounted on a steel-welded frame, which also carries underneath a pair of steel bottles arranged to act as oil separators and air receivers. The com-

pieces of the same material secured to the air injectors. The forced draught is created by steam jets in the same manner as the Crosthwaite standard furnace, each section having one jet. The grate sections are carried at the front on a mild steel girder, which is, in turn, carried on cast iron pillars from the floor. These pillars also support the furnace fronts, thus ensuring that the weight of the stoker and furnace is not carried by the front plate of the boiler. The grate is carried at the back on a strong cast iron bridge, which is fitted with a hinged door for cleaning purposes. The stoker and self-cleaning furnace are driven by entirely separate gear-boxes, so that the speed of the stoker may be altered independently of the furnace, and *vice versâ*. Each box contains a double gear worm reduction, both worms and both worm wheels being machine cut from the solid. The worms are fitted with ball thrust bearings, and the wheels run in oil baths.